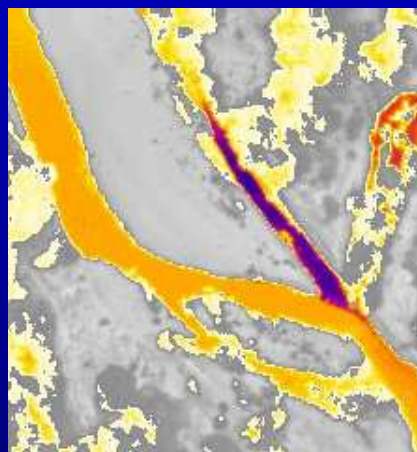


Information and Insights Gained from the 2003 Shasta River Thermal Infrared Survey



Presented to
Shasta Valley RCD,
May 12, 2004

by Matt St. John & Bryan McFadin, NCRWQCB

Terminology

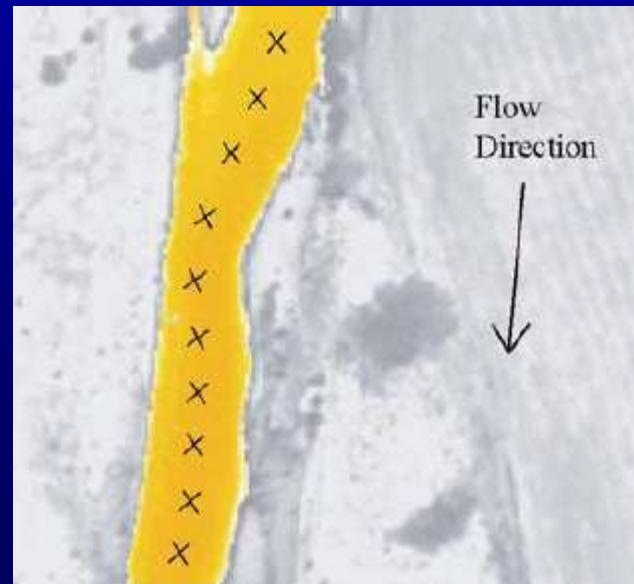
- TIR: Thermal InfraRed
- FLIR: Forward-Looking Infrared
- Surface water: Above-ground water
- Subsurface water: Below-ground water
- Hyporheic water: Subsurface stream water
- Groundwater: Subsurface water, generally derived from percolated precipitation or winter recharge

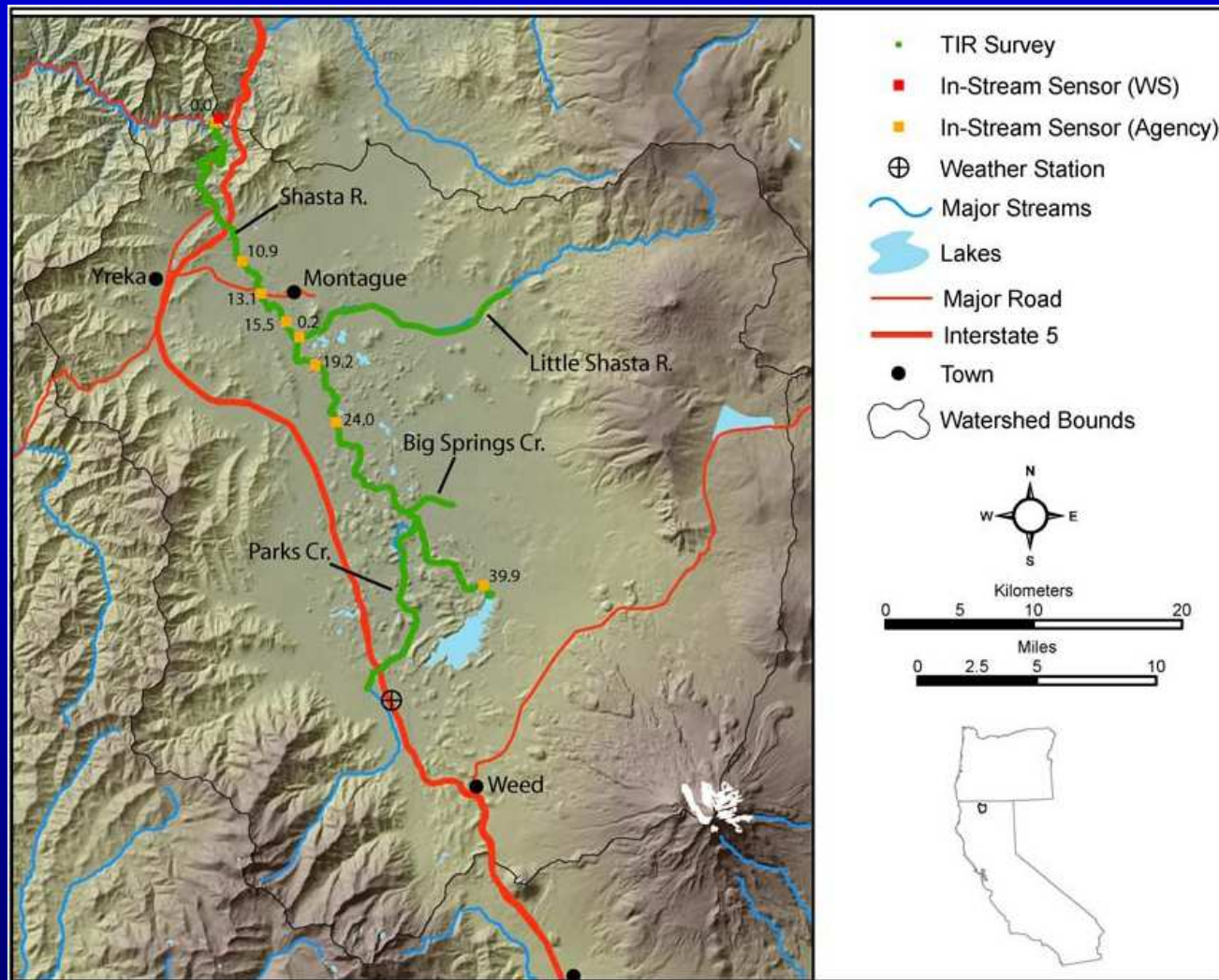
Overview

- How FLIR data is collected
- Geographic scope of survey
- FLIR data products
- Data quality
- Uses of FLIR data
- Shasta River FLIR results
- Thermal processes in the Shasta River
- Questions

How FLIR data is generated

- Infrared sensor and video camera are mounted side-by-side
- Each frame is assigned GPS coordinates
- Infrared measurements are calibrated using in-stream temperature measurements
- Stream temperatures are manually measured and summary statistics generated for individual frames
- GIS database is created with spatial, thermal, and other information





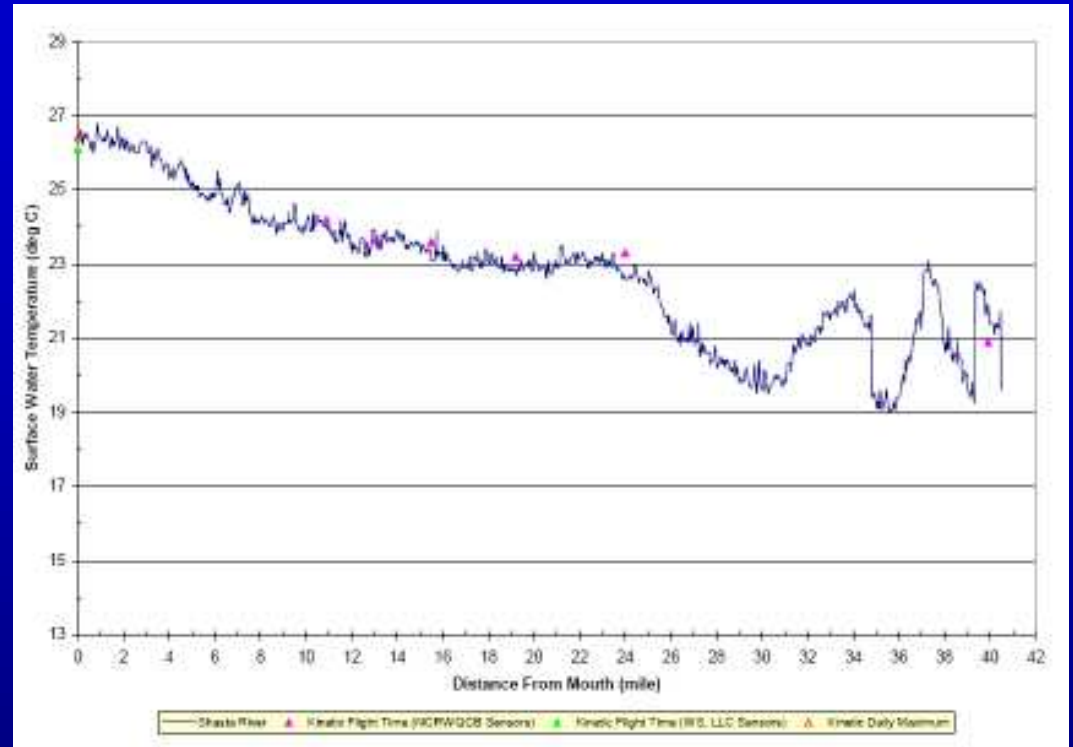
Map showing the streams surveyed in the Shasta River Sub-Basin using TIR and color video on July 26-27, 2003. The map also shows the location of the in-stream sensors used to ground truth the imagery, labeled by river mile.

FLIR Data Products

Data Quality

Comparison of infrared and in-stream measurements shows excellent correlation.

Average absolute difference = 0.4 deg C (0.7 deg F)

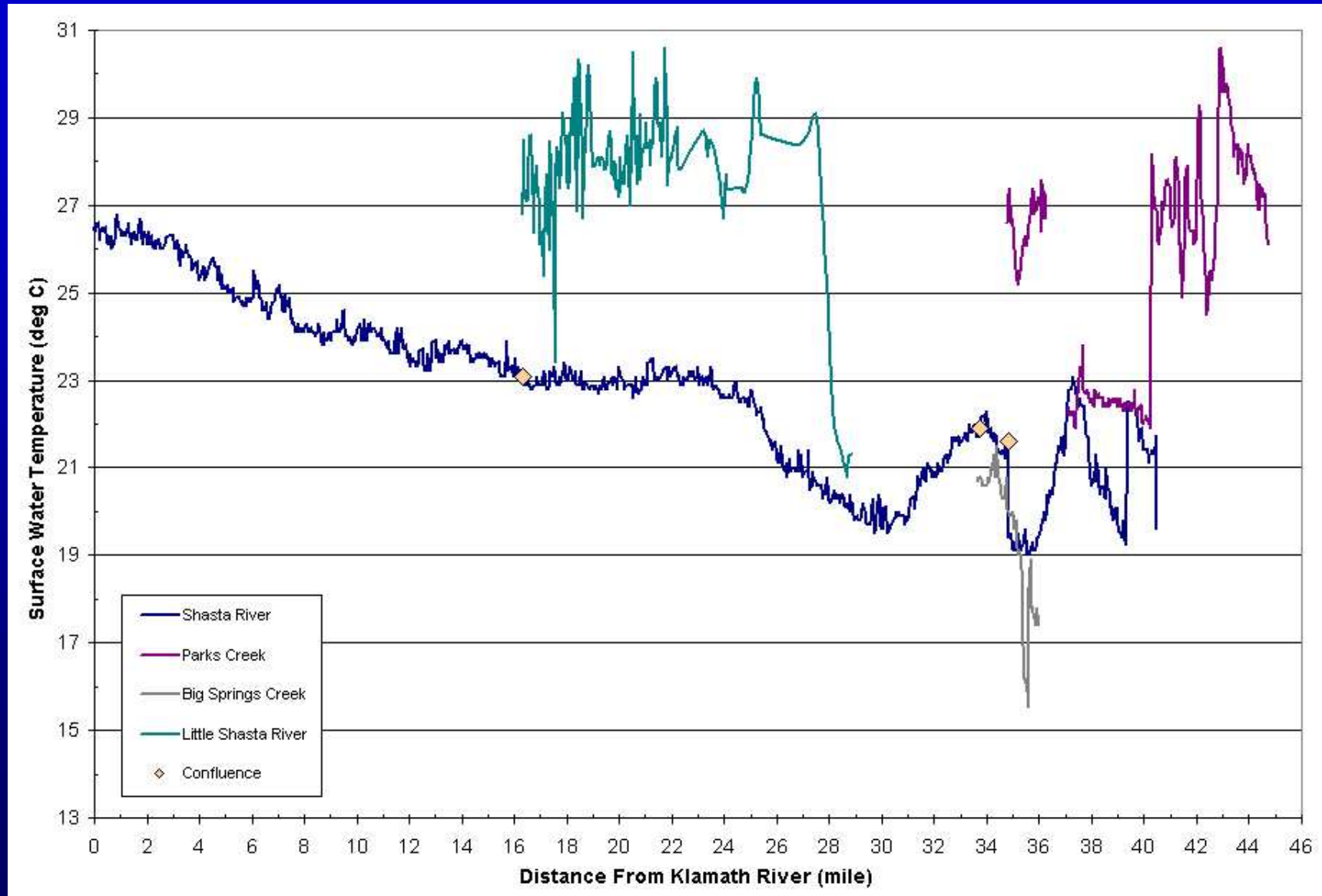


Median stream temperatures versus river mile for the Shasta River. The plot also shows the kinetic temperatures at the time of the survey and the maximum daily stream temperature at the ground truth locations.

Uses of FLIR data

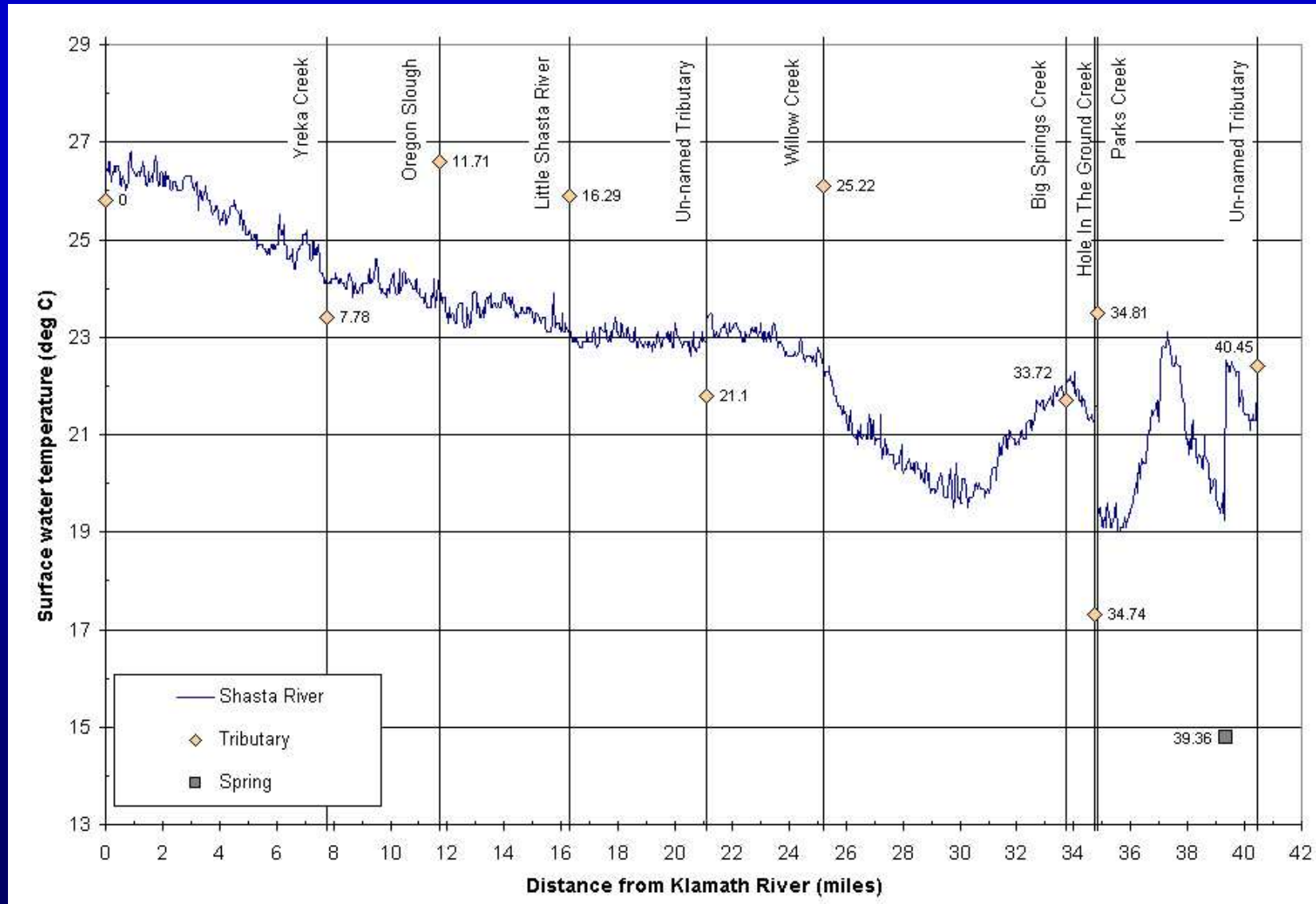
- Stream temperature snapshot
- Identification of thermal refugia
- Calibration of stream temperature models
- Identification of subsurface inflows
- Estimation of tributary flow rates/proportions
- High-resolution (1:1000) riparian imagery

Results

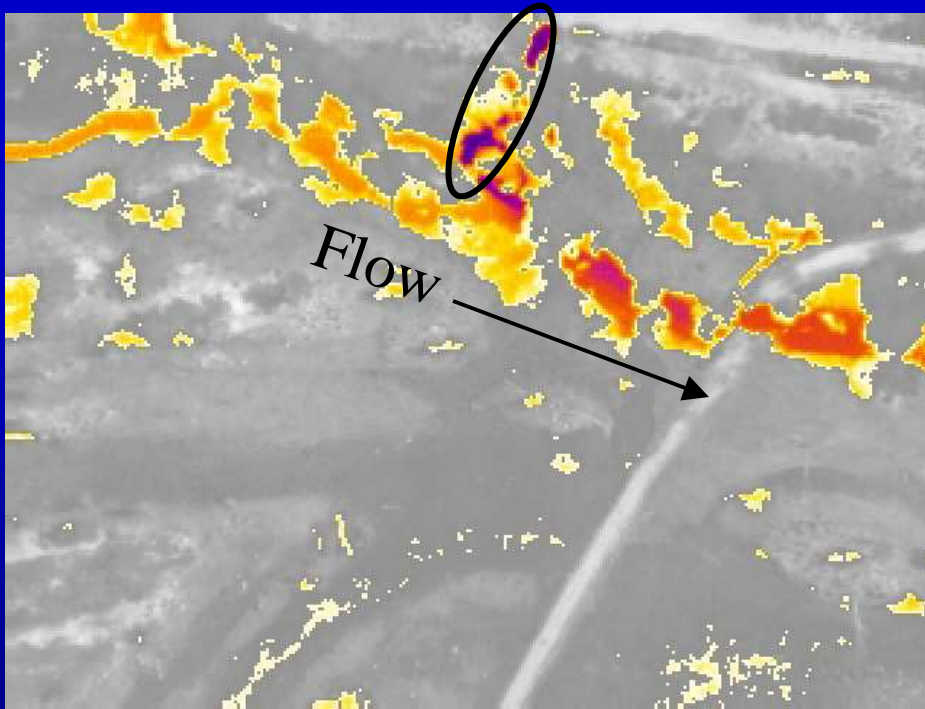


2003 Shasta River Thermal Infrared Survey Results

Shasta River FLIR Results



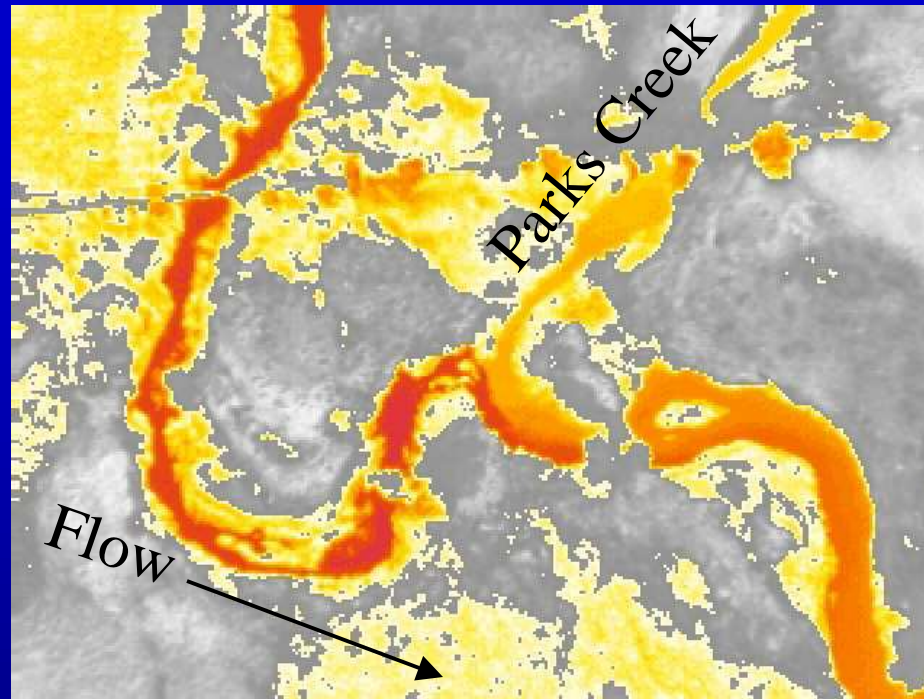
Shasta River (river mile 39.4)



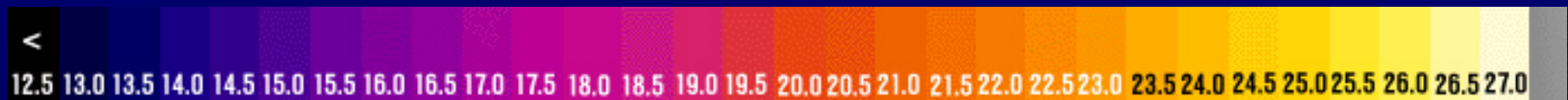
A spring lowered stream temperatures in the Shasta River
from 22.5 C to 19.3 C



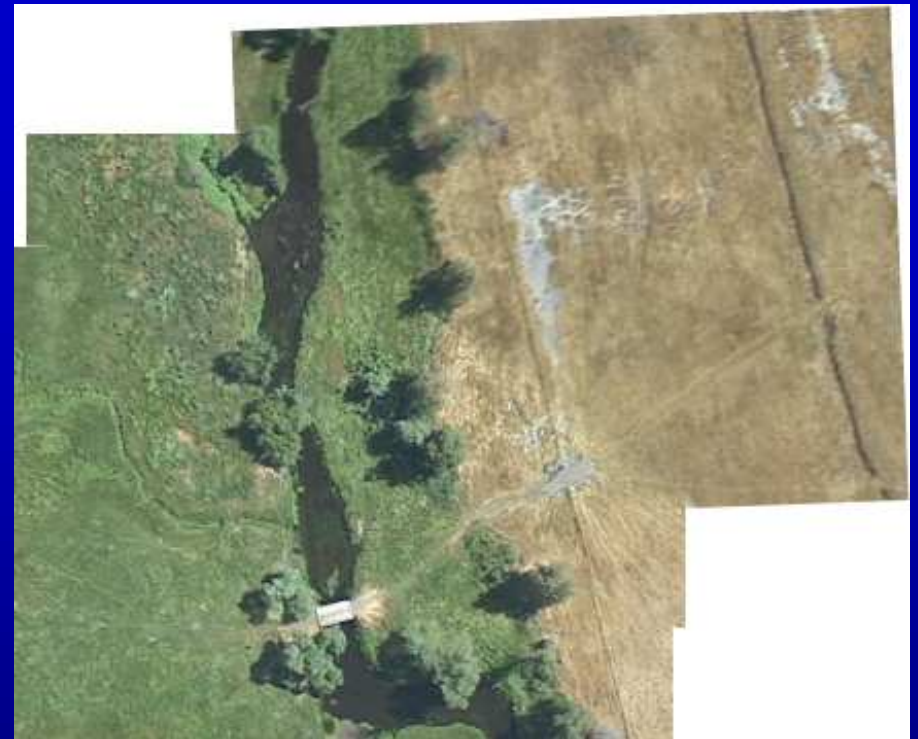
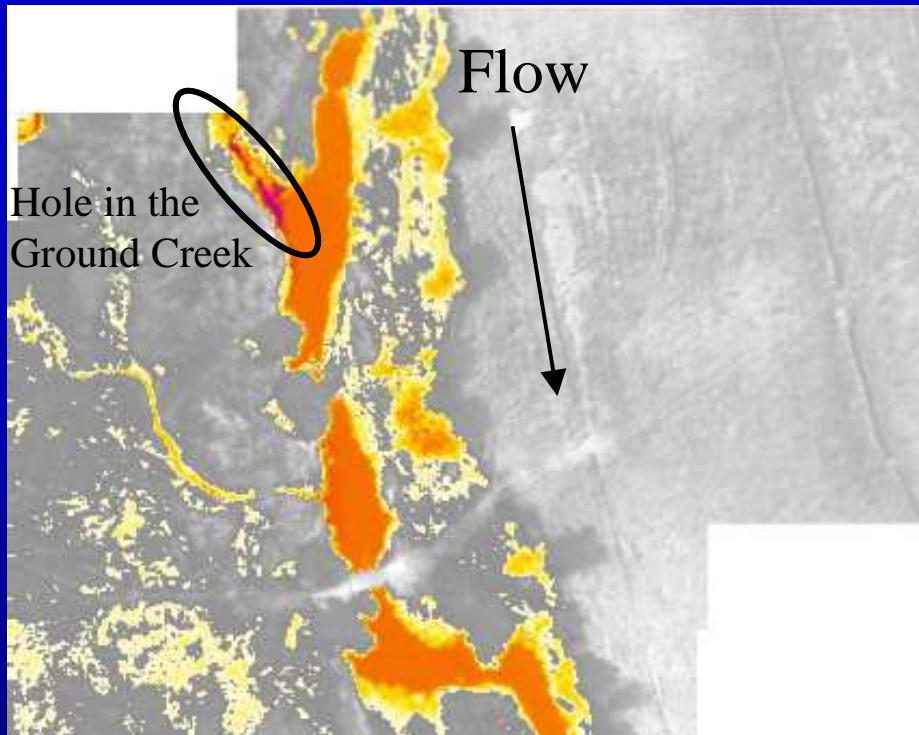
Shasta River (river mile 34.8)



Parks Creek was a source of warm water, increasing the mainstem temperature by 1.7 C



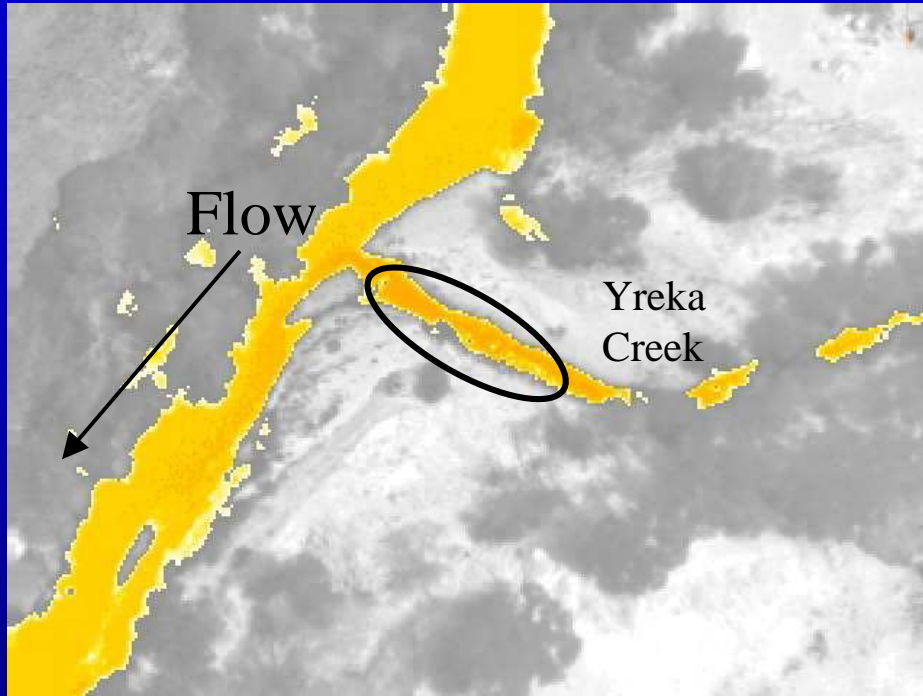
Shasta River (river mile 34.7)



Confluence of Hole in the Ground Creek (17.3 C) and the mainstem Shasta River (21.6 C)



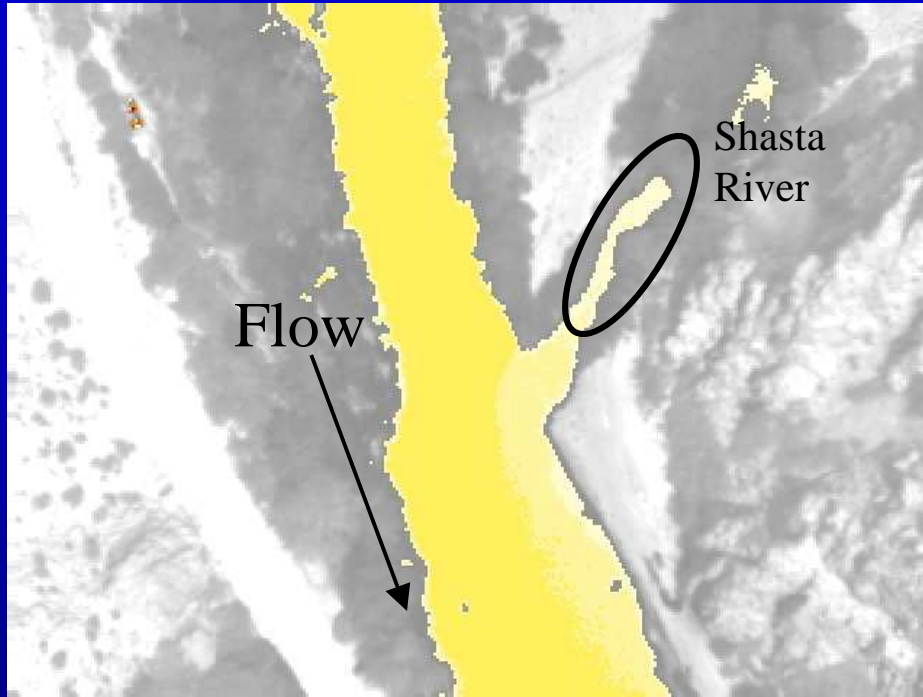
Shasta River (river mile 7.8)



Confluence of Yreka Creek (23.4 C) and the mainstem Shasta River (24.2 C)



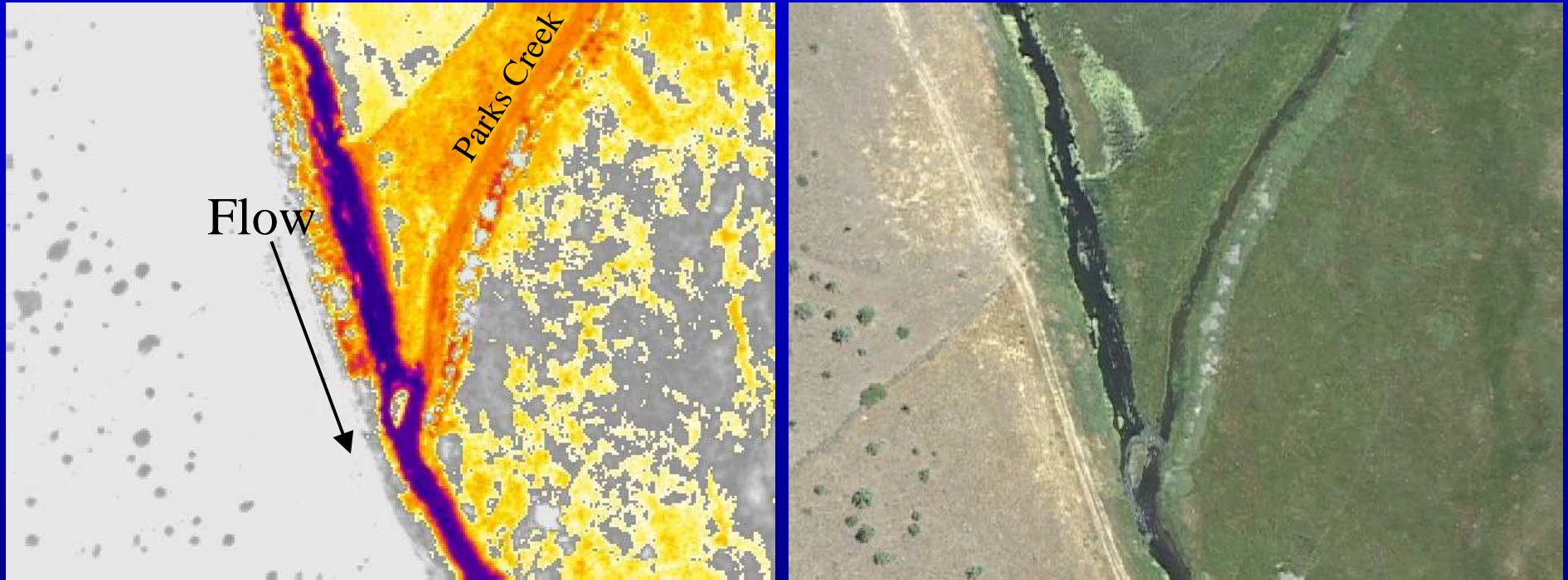
Shasta River (river mile 0.0)



Confluence of Shasta River (26.5 C) and Klamath River (25.8 C)



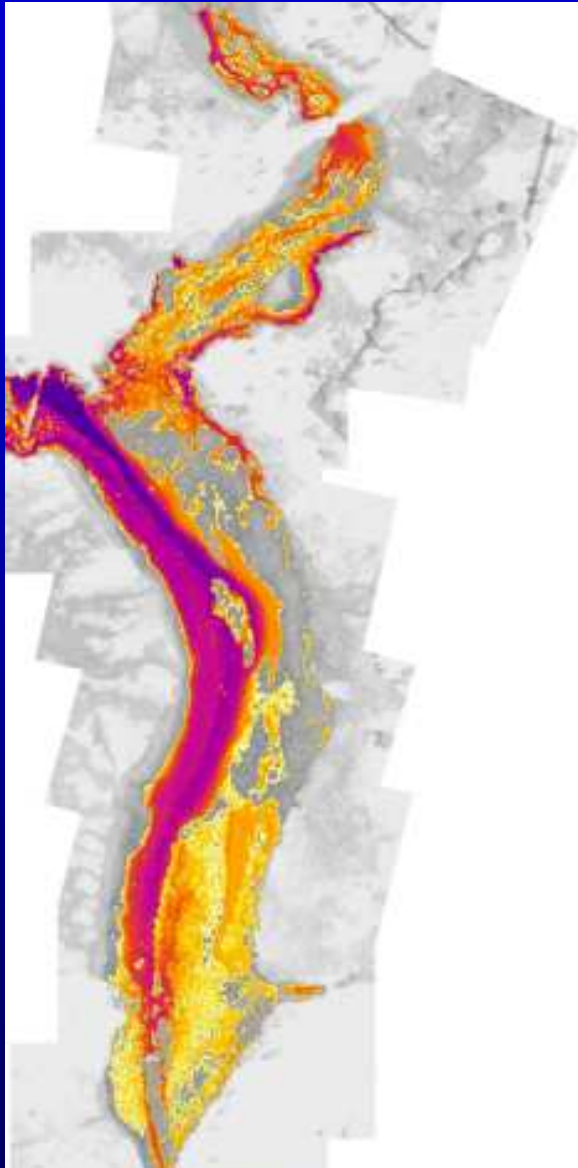
Parks Creek (river mile 5.5)



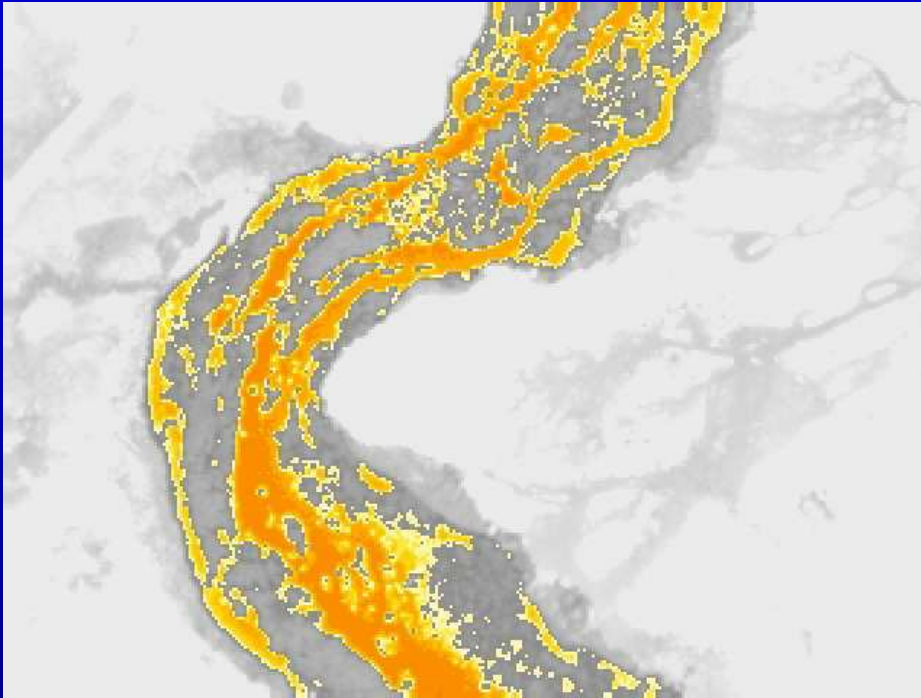
Confluence of Parks Creek and a canal carrying cooler water.
The inflow of the canal dictated the temperature of Parks Creek.



Big Springs Creek (RM 2.0)



Big Springs Creek (RM 1.4)



Conclusions

- Thermal infrared surveys provide reliable high resolution temperature data useful for identifying river heating and cooling sources
- The exchange of surface and subsurface water is an important thermal process in the Shasta River and tributaries
- There are many opportunities to mitigate high stream temperatures

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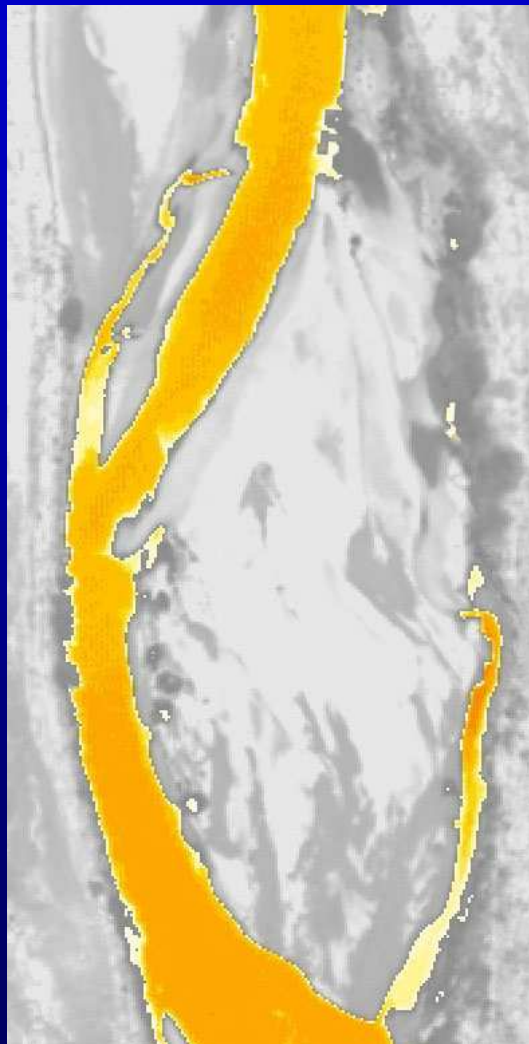
mcfab@rb1.swrcb.ca.gov

5550 Skylane Blvd, Ste. A

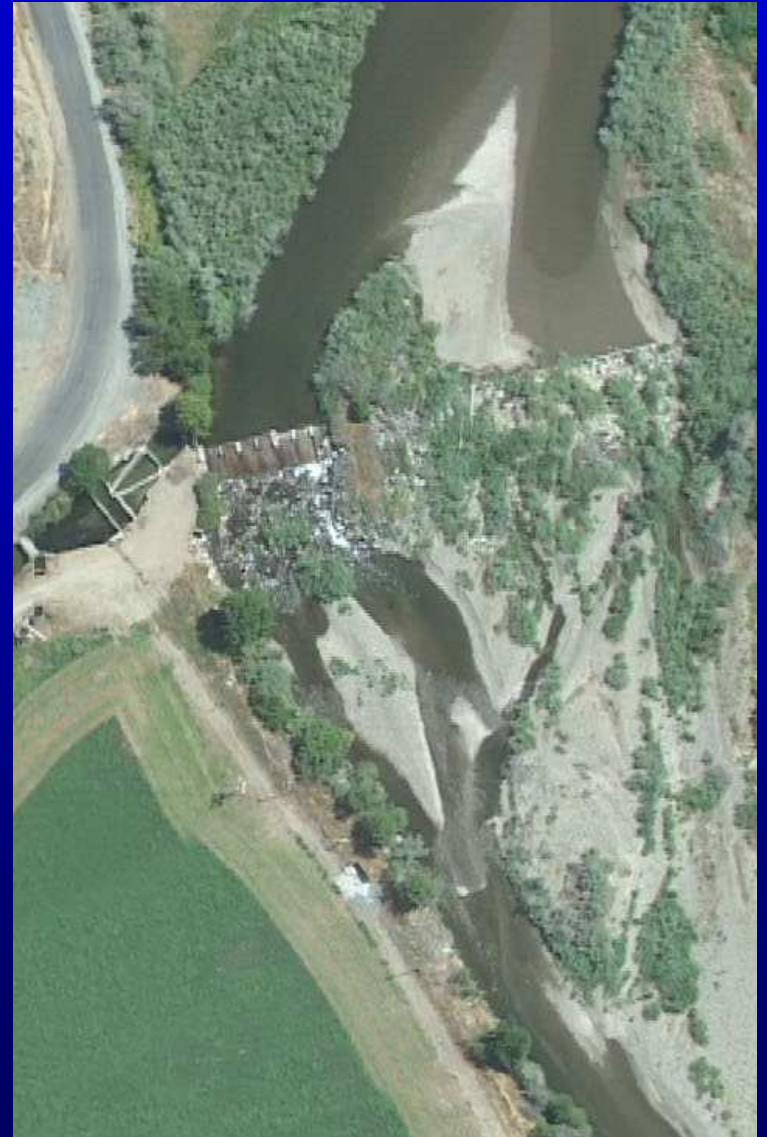
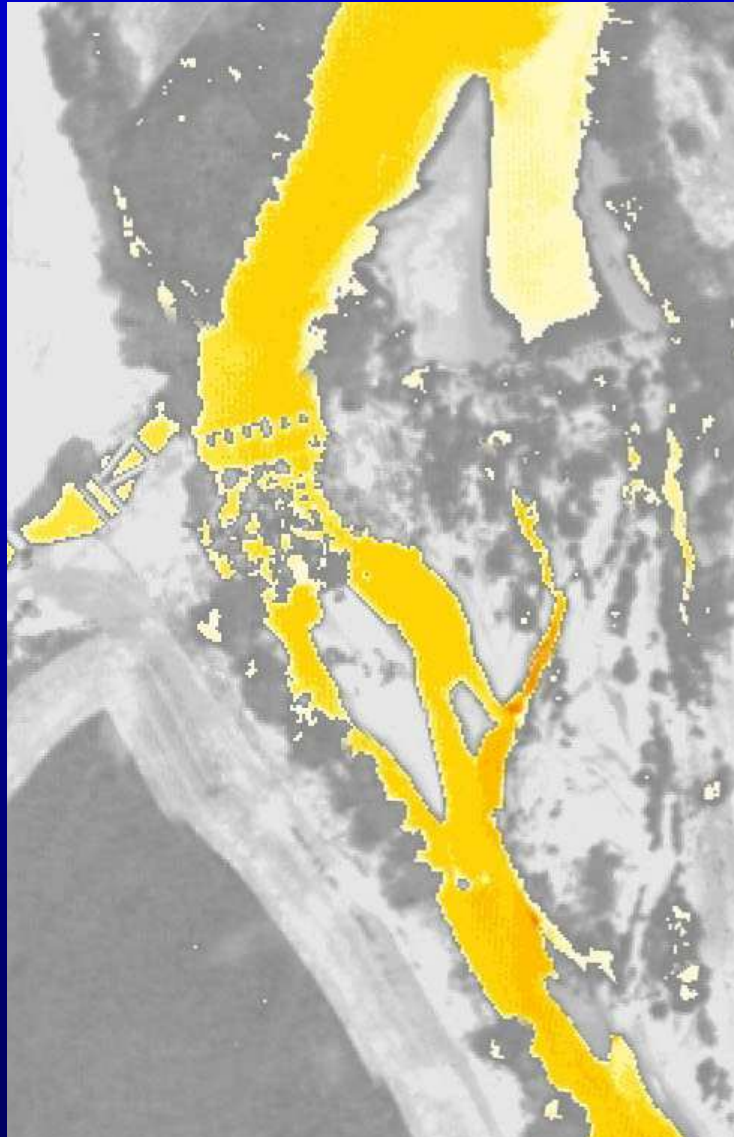
Santa Rosa, CA 95403

www.watershedsciences.com

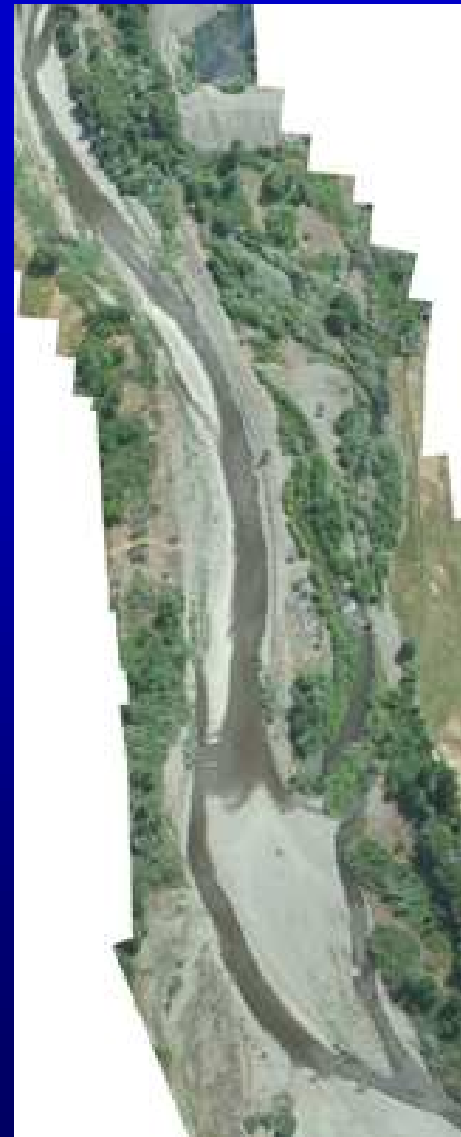
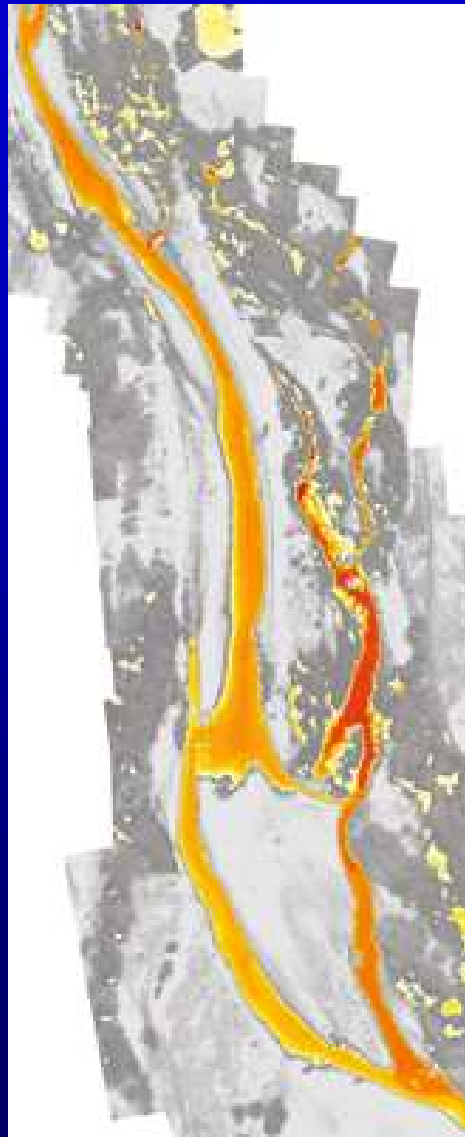
Surface - subsurface interaction at river mile 42



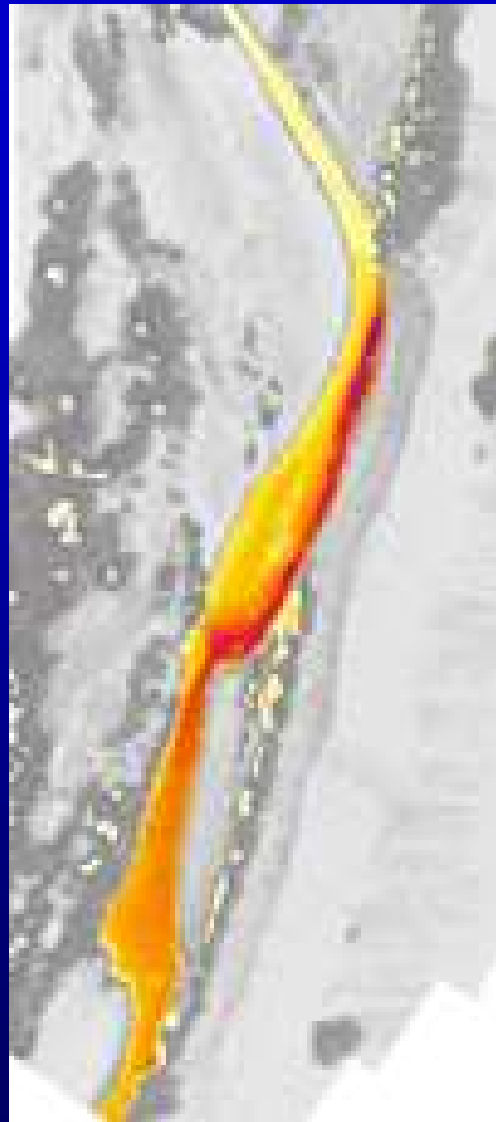
Hyporheic return below SVID Dam, RM 46.5



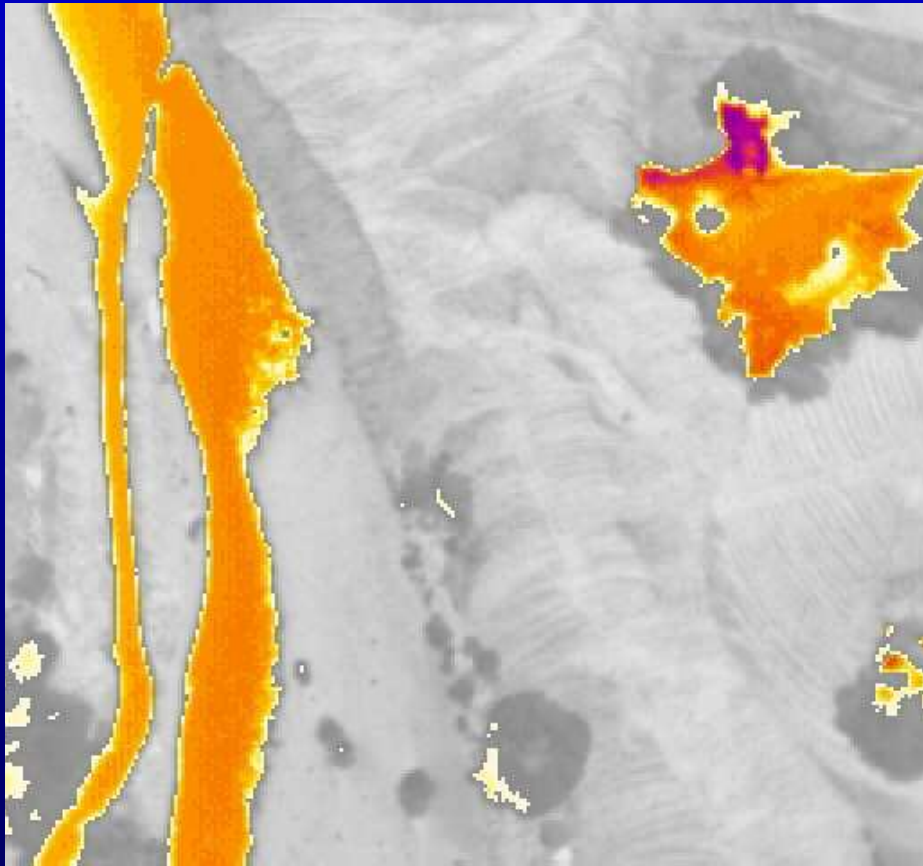
Spring complex at river mile 52.0



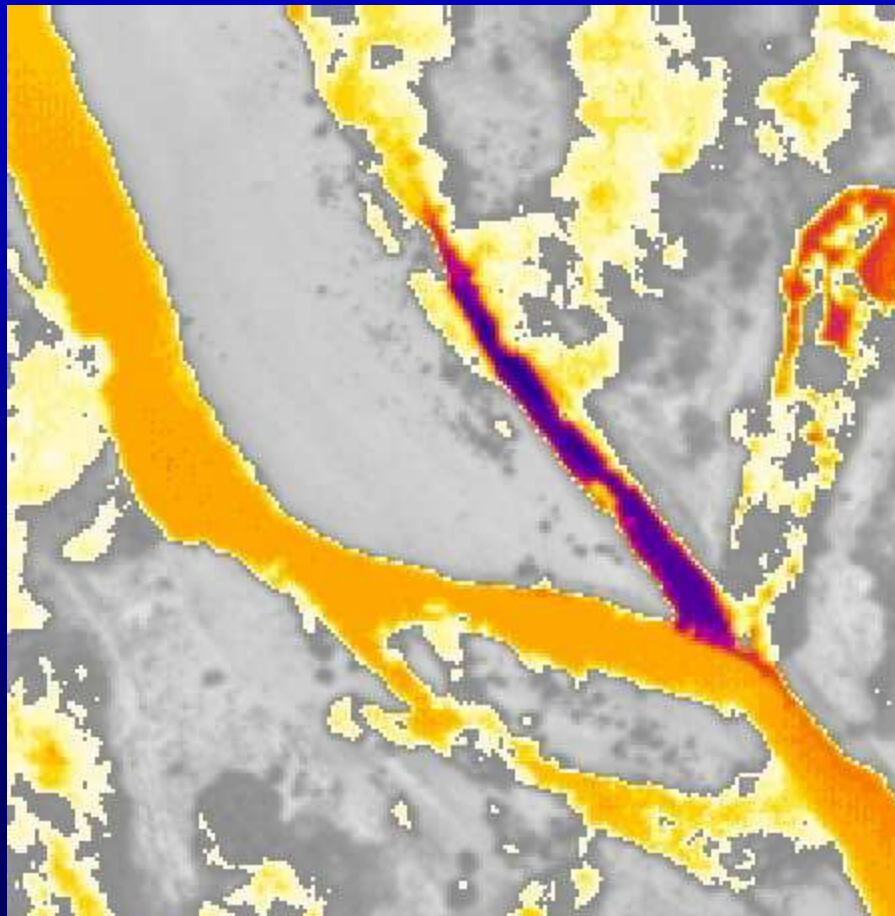
Spring at river mile 52.3



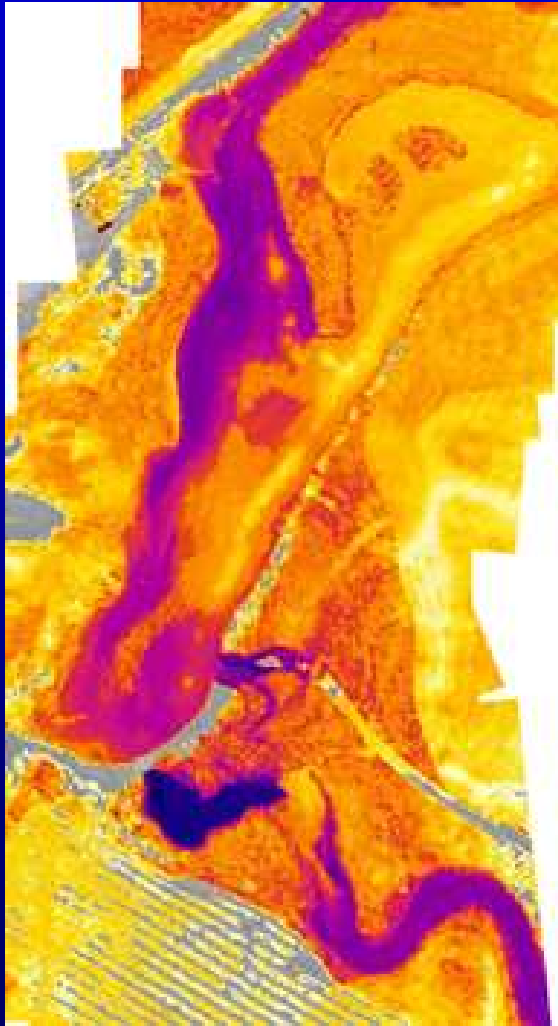
Hyporheic exchange, tailings ponds



Thermal refuge at river mile 54.3, Sugar Creek underflow



Stratification of Big Slough, river mile 6.0



Surface - subsurface interaction at river mile 47.7



Stratified pool at river mile 47.7



Groundwater at river mile 42



Hyporheic water emerging from the foot of a tailings pile



Hyporheic water emerging from the foot of a tailings pile

